

# Alternative Fuel

## FLEET START-UP EXPERIENCE

May 1999

U.S. DEPARTMENT of ENERGY,  
OFFICE of ENERGY EFFICIENCY and RENEWABLE ENERGY

### Denver SuperShuttle CNG Fleet Evaluation

Gas Research Institute (GRI) and the U.S. Department of Energy (DOE), along with several industry partners, are collaborating with SuperShuttle of Denver, Colorado, to evaluate natural gas vans in the SuperShuttle fleet. The study will evaluate two of the latest natural gas vehicle technologies available from the original equipment manufacturers (OEMs). Brand new (1999 model year) dedicated and bi-fuel (see sidebar) compressed natural gas (CNG) vehicles manufactured by Ford Motor Company will be operated side-by-side with three similar gasoline vehicles in normal revenue service. The study vehicles will be operated out of Boulder, Colorado, with shuttle service to Denver International Airport (DIA).

This project, jointly sponsored by GRI and DOE's Office of Technology Utilization, and managed by DOE's National Renewable Energy Laboratory (NREL), was designed to provide real-world information on implementing and operating alternative fuel vehicles (AFVs). Fleet representatives who are considering AFVs can use this information as they make decisions about what type of alternative fuel or vehicle will best meet their needs. Data on the costs of operating and maintaining the vehicles, their performance, their emissions, and the fleet's general implementation experiences will be collected for approximately 12 months (from March 1999 to March 2000).

#### CNG Vehicle Choices

The term "dedicated" describes a vehicle designed to operate on only one fuel. Several vehicle design modifications were completed at the factory to enable the vans to operate on a gaseous fuel:

- Replacing the fuel tank with high-pressure gas cylinders
- Installing intake valve seat inserts and hard-faced exhaust valves
- Performing unique calibrations and programming the electronic control module
- Adding actuators and sensors to control the air/fuel ratio
- Incorporating fuel management equipment, such as pressure relief devices.

Bi-fuel vehicles are equipped to carry both gasoline and natural gas, fuels that require separate fuel systems. The bi-fuel engine design modifications are similar to those needed on the dedicated gaseous fuel model, except that the gasoline system is not replaced. Most bi-fuel vehicles sold today are designed to operate on the alternative fuel until the pressure in the gaseous fuel tank falls below a pre-set value, when the system automatically switches to gasoline. This study will look into issues related to the choice of a dedicated or bi-fuel vehicle. For instance, NREL will study how the fleet is affected by differences in driving range, maintenance costs, vehicle performance, and emissions.

#### The SuperShuttle Story

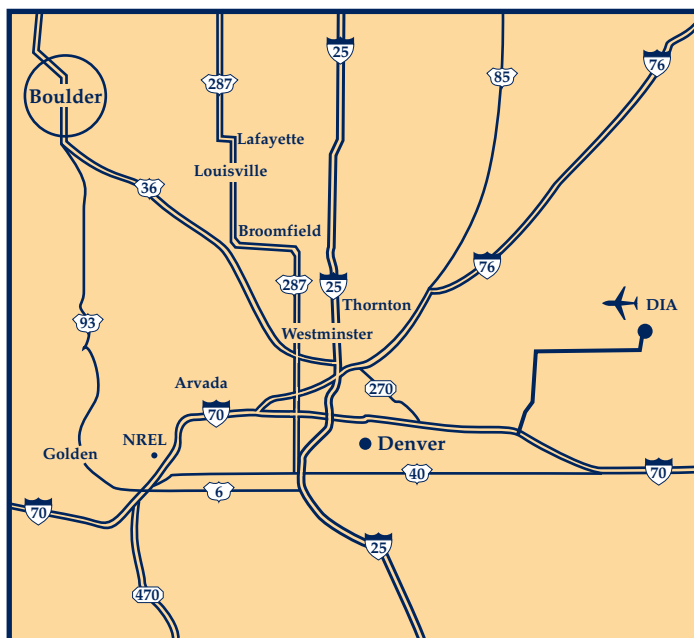
SuperShuttle opened its doors in Los Angeles in 1983, focusing on shared ride door-to-door airport passenger service. The company's goal was to become the premier U.S. shuttle service by providing outstanding customer service. Since then, SuperShuttle has grown to service 15 airports, transporting more than 7 million customers each year. In Colorado, the company has been operating in Denver since mid 1996, servicing the local community and DIA. Its fleet of 85 vehicles includes 18 AFVs, fueled by either liquefied petroleum gas (LPG) or CNG.



## Fleet Facts

Fleet Type:	Vans in airport shuttle service
Fleet Size:	85 vans and shuttle buses, of which 18 are AFVs
Alternative Fuel:	CNG and LPG
Study Vehicles:	Passenger vans: 5 dedicated CNG, 5 bi-fuel CNG, and 3 gasoline
Service Area:	Boulder, CO to DIA
Mileage Accumulation:	~70,000 miles annually

## Service Area



SuperShuttle Denver General Manager Ross Alexander cited several reasons for adding AFVs to its lineup. Concern about local air quality was high on his list. "Boulder is an environmentally conscious city. We knew we would get a positive reaction from the community by using clean technology vehicles. Also, the rebates and tax incentives offered to AFV buyers make them comparable in price to their gasoline counterparts."

Several rebates, credits, and tax incentives are available to fleets that purchase AFVs. For SuperShuttle Denver, the incentives they could take advantage of included:

- A \$2000 discount per vehicle from Ford to AFV purchasers to help offset the incremental cost of the vehicles

- A rebate to AFV buyers from the Colorado Office of Energy Conservation, in partnership with the Colorado Oil and Gas Association, based on the emissions certification level of the vehicle

- Super ultra low-emission vehicle (SULEV) = 80% of the incremental cost
- Low-emission vehicle (LEV) = 50% of the incremental cost

- Tax credits from the State of Colorado

- 1998 and prior purchases generate lesser of 5% of vehicle purchase price or 50% of the OEM alternative fuel system option
- 1999 and later purchases generate 50% to 100% of incremental cost of vehicle depending on emissions certification (e.g., LEV, ULEV, SULEV, ZEV).

- Federal tax deductions under the Energy Policy Act of 1992 (EPAct). Businesses and individuals may deduct from their taxable income the incremental cost of AFVs (up to \$2000 maximum per vehicle)

Colorado has also enacted a Clean Fuel Fleet Program (CFFP) to reduce emissions from vehicle exhaust by requiring fleets with 10 or more vehicles operating in the Denver carbon monoxide non-attainment area, to include clean fuel vehicles (CFVs) in their fleets on a percentage basis. By purchasing CFVs, SuperShuttle could satisfy their CFFP requirements (see Denver Air Quality sidebar).

With the combination of CFFP requirements, significant financial incentives, and the area's existing CNG fueling infrastructure, Jeff Frasier of Natural Fuels Company saw that SuperShuttle was a perfect candidate for introducing natural gas vehicles (NGVs). In addition, because CNG is less expensive than gasoline, Frasier believed that the high mileage application should allow the company to realize immediate cost savings. Shortly after Frasier made a presentation to SuperShuttle management outlining these potential advantages and explaining the financial incentives available to fleets purchasing AFVs, SuperShuttle placed an order for the 10 CNG vehicles.

## Putting the Pieces Together—A Team Effort

Sill-Terhar Ford in Broomfield, Colorado, a local Ford dealership, handled the vehicle orders and will provide warranty work and complete any major repairs. Sill-Terhar Ford became an authorized AFV

dealership through Ford about 1½ years ago. To become certified to sell and service AFVs, the service personnel took a 3-day training course given by Ford. The dealership also purchased approximately \$5,000 in equipment for servicing CNG vehicles. For Sill-Terhar Fleet Account Manager Boysen Loesch, this was an important step. "We were interested in the environment and improving air quality, and felt that there was a market for these clean vehicles in the Denver area."

Natural Fuels Company paved the way for SuperShuttle's AFV implementation in several ways. Natural Fuels set up a CNG fueling account that included separate fueling cards for each van; these cards allow the drivers to fuel the vans at any of 35 public-access Natural Fuels CNG fueling sites. To ensure the fleet's supply of natural gas, Natural Fuels increased compression and storage capacity at its fueling site closest to SuperShuttle's Boulder location. Finally, the corporation set up a CNG training session for the drivers and other fleet personnel.



As these pieces were coming together, GRI was talking with Ford Motor Company representatives about testing NGVs in a real-world setting. GRI's NGV program seeks to develop and deploy technologies and products that support vehicle and infrastructure developments. GRI staff believes that these technologies and products enable consumers to realize the environmental, economic, safety, and energy security benefits resulting from using natural gas as a transportation fuel.

GRI was looking for a study fleet where the emissions of OEM dedicated, bi-fuel, and gasoline vehicles could be compared side by side. The fleet would also need to be located in an area with an existing fueling infrastructure. According to Rajeeva Gable of GRI, SuperShuttle Denver fit these needs perfectly. "This evaluation will enable us to collect emissions data in a controlled setting with equal commitment from the fleet, vehicle service provider, fuel provider, and other participants."

DOE's and NREL's goals in the transportation arena (to reduce the nation's dependence on foreign oil supplies, while improving air quality, by developing and demonstrating innovative technologies that allow alternative fuels and advanced vehicle systems to supply a significant portion of the nation's transportation needs) are similar to GRI's. DOE and NREL are interested in all alternative fuel possibilities; GRI focuses primarily on natural gas. Because of their mutual interest in providing information on fleet experiences with alternative fuels, GRI and NREL set up a cooperative research and development agreement (CRADA, see sidebar) to pool private and public resources for this project.

## What is a CRADA ?

A CRADA is a written statement between a private company and a government agency agreeing to conduct joint research. In 1980, the Stevenson-Wydler Technology Innovation Act established the foundation for technology transfer within the federal government. This law required federal laboratories to take an active role in disseminating information from government to private industry. The Federal Technology Transfer Act of 1986 amended the former law to make every federal scientist and engineering professional responsible for actively seeking opportunities for technology transfer. One of the methods for this technology transfer is a CRADA.

SuperShuttle promises to be an excellent study fleet because of a combination of the vehicles' high mileage accumulation, the side-by-side comparison of technology options, the enthusiasm of the company's management, and the supportive partners.

## Getting Started

Although the AFVs were ordered in early September and scheduled to arrive in early December 1998, they were not delivered until March 1999. During the manufacturing process, Ford discovered a part that did not meet its quality standards: the plating on the CNG fueling valve was breaking away and clogging the check valve. Ford halted production of its CNG vehicles temporarily while Ford's supplier corrected the problem. For Ford, catching this problem early prevented problems with the vehicles once they went out to customers.



Unfortunately, this put SuperShuttle in a difficult position. The vans SuperShuttle was leasing had to be returned to the leasing company by January 1999, leaving SuperShuttle without enough vans to run its Boulder operation. To help, Natural Fuels temporarily loaned SuperShuttle a CNG van.

In addition, SuperShuttle leased a couple of older vans from its Denver location, plus two more vans from private parties. Even then, SuperShuttle's service had to be supplemented with taxi cabs. The burden was eased somewhat when the three gasoline vans, to be used as control vehicles for the study, arrived in late February. As another consequence of the delay, SuperShuttle was unable to receive the federal tax deduction under EAct and the Colorado state tax credits in 1998.

But in March 1999, 10 AFVs were successfully delivered to the Boulder SuperShuttle office, where the vehicles are based. The vehicles are 1999 Ford E350 super-duty extended wagons—five are dedicated CNG and five are bi-fuel CNG/gasoline. They are operated in two basic service applications: in town around the Boulder area, and on the highway between Boulder and DIA. The vans are expected to accumulate more than 70,000 miles per year. The table below lists the specifications for the vans.

### By the Numbers: Vehicle Specifications

Make	Ford	Ford	Ford
Model	E-350 van	E-350 van	E-350 van
Model Year	1999	1999	1999
Engine Displacement	5.4L	5.4L	5.4L
Engine Configuration	V8	V8	V8
Horsepower	206	206	235
Fuel/System	CNG/dedicated	CNG/bi-fuel	Gasoline
Fuel Tank Capacity	14 gge <sup>1</sup>	8.5 gge CNG/ 35 gallons of gasoline \	35 gallons
GVWR (lb)	9400	9400	9400
Passenger Capacity	15	15	15
Emissions Certification	Federal ULEV/ILEV, <sup>2</sup> CA SULEV <sup>3</sup>	LEV	

<sup>1</sup>gge = gasoline gallon equivalent

<sup>2</sup>Federal ULEV/inherently low-emission vehicle

<sup>3</sup>California super ultra low-emission vehicle

## Lessons Learned to Date

### Communication between project partners is essential.

Information about the alternative fuel technology is available, but not always easy to locate. It takes good communication among manufacturers, fleet customers, and other industry partners to get the needed information to those making the decisions about implementing AFVs in their operations.

### Train vehicle operators in the new technology.

Thorough training of personnel will smooth the transition to alternative fuels. To become comfortable with maintaining and operating the vehicles, drivers and technicians need to understand the differences between the new technology and the technology to which they are accustomed. Recognize that there will be a learning curve.

**Plan ahead.** Implementing a new technology can take time. Research your options, anticipate possible problems, and formulate a "backup plan."

**Support from the fuel industry and partners is important.** Problems will arise during the start-up phase of this type of program. Complete support from the project participants will make troubleshooting and problem solving easier.

## What's Next?

To obtain a complete picture of this fleet's AFV experience, NREL will collect all fueling, maintenance, and other operational data, including costs and details on each service, on the 13 vehicles. Emissions tests will be performed on the vans at three mileage intervals: 10,000, 40,000, and 70,000 miles. At each mileage interval, the vehicles will undergo EPA's Federal Test Procedure for emissions certification. Typical compounds measured during this test include carbon monoxide, hydrocarbons, and oxides of nitrogen. More detailed procedures will be conducted during the 40,000-mile tests. These tests will help to verify the emissions that result from using alternative fuels and will provide a comparison between the two CNG technologies (dedicated versus bi-fuel). A fleet's more subjective experience with AFVs is also important to help those considering adding alternative fuels to their operations. To collect this information, NREL will conduct surveys questioning drivers, service personnel, and fleet customers about implementation experiences, opinions and perceptions, and general acceptance.

NREL will analyze the results and publish an interim report and a final report, which will be available through this DOE World Wide Web site:  
[www.ott.doe.gov/otu/field\\_ops/lightduty.html](http://www.ott.doe.gov/otu/field_ops/lightduty.html)

## Denver's Air Quality

The Denver metropolitan area has a history of air quality problems. Because of the local topography and weather patterns, pollution from urban sources is sometimes suspended over the area, resulting in a "brown cloud" over the region. Under the Clean Air Act Amendments (CAAA) of 1990, EPA has classified the Denver/Boulder region as a nonattainment area for carbon monoxide (CO) and particulate matter (PM). To reduce vehicle emissions and fulfill the provisions of the CAAA, Colorado enacted the CFFP. The program covers private and government fleets with 10 or more vehicles registered in the Denver/Boulder CO nonattainment area. Beginning with the 1999 model year, 30% of new light-duty vehicle (<8,501 lb) and 50% of heavy-duty vehicle (26,000–8,501 lb) acquisitions by covered fleets must be CFVs (i.e., vehicles certified by the EPA to LEV or better emission standards). The light-duty acquisition requirements increase to 50% in 2000 and 70% in 2001 and thereafter; heavy-duty requirements remain at 50%. Extra acquisition credits can be earned by acquiring more CFVs than required in a given year and/or by acquiring vehicles certified to the more stringent ULEV and zero-emission vehicle (ZEV) standards. The extra credits may be banked for the fleet's own use in future years, or purchased, traded, or sold within the covered Denver nonattainment area.



SuperShuttle's Ford E-350 vans are rated as heavy-duty vehicles; therefore, assuming that the company will only acquire these 13 vehicles this model year, 6 must be CFV's. The five bi-fuel models are certified to LEV standards (but only when operating on CNG), and so do not generate extra credits. These bi-fuel vehicles must be operated on CNG to maintain their CFV status.

However, the 5 dedicated CNG models are certified to ULEV standards, which means that they generate nine extra credits (one extra for one van that brought the CFV number to the required six and two each for the remaining four dedicated vehicles).

## Acknowledgments

This project is one of the focus fleet studies sponsored by DOE's Office of Technology Utilization and managed by NREL. All these studies are designed to collect and provide objective information on real-world fleet experiences with AFVs and to demonstrate that AFVs can meet the vehicle needs of fleets. This AFV evaluation is a cooperative effort supported with funding or technical assistance from the following organizations:

Participants	Role/Responsibility
SuperShuttle Denver	Purchasing and operating vehicles, providing operational and maintenance data
Gas Research Institute	Providing funding for data collection and emissions as a joint project sponsor (through a CRADA with NREL)
U.S. Department of Energy	Providing funding for data collection, analysis, and reporting as a joint project sponsor
Natural Fuels Corporation	Providing fuel, advising SuperShuttle on financial and technical issues, and managing emissions contract
National Renewable Energy Laboratory	Managing project as well as collecting, analyzing, and reporting vehicle operational, performance, and emissions data
Ford/Sill-Terhar Dealership	Servicing vehicles
Ford Motor Company	Providing technical assistance and rebates
Environmental Testing Corporation	Conducting vehicle emissions tests at prescribed mileage intervals
Colorado Department of Public Health	Supplying technical input on emissions testing



## For More Information

For more general information on alternative fuels, AFVs, and related topics, contact the National Alternative Fuels Hotline at 1-800-423-1363 or the Alternative Fuels Data Center at <http://www.afdc.doe.gov>

For more specific information on this project, contact:

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